Good Morning

CANS
Chinese - American Networking Symposium

早晨好

Cyberinfrastructure and Grid Technology

A Platform for Revolutionizing Learning and Discovery

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http://www.canscouncil.net/

Office of Cyberinfrastructure

D. E. Atkins

Current Nomenclature

ACLS-Mellon Study: Cyberinfrastructure for Humanities http://www.acls.org/cyberinfrastructure/

HASTAC Project http://www.hastac.org/

research & learning

science

engineering

rapid response

humanities

world universities

CI-enhanced | enabled

Cyber science

e-research

e-science
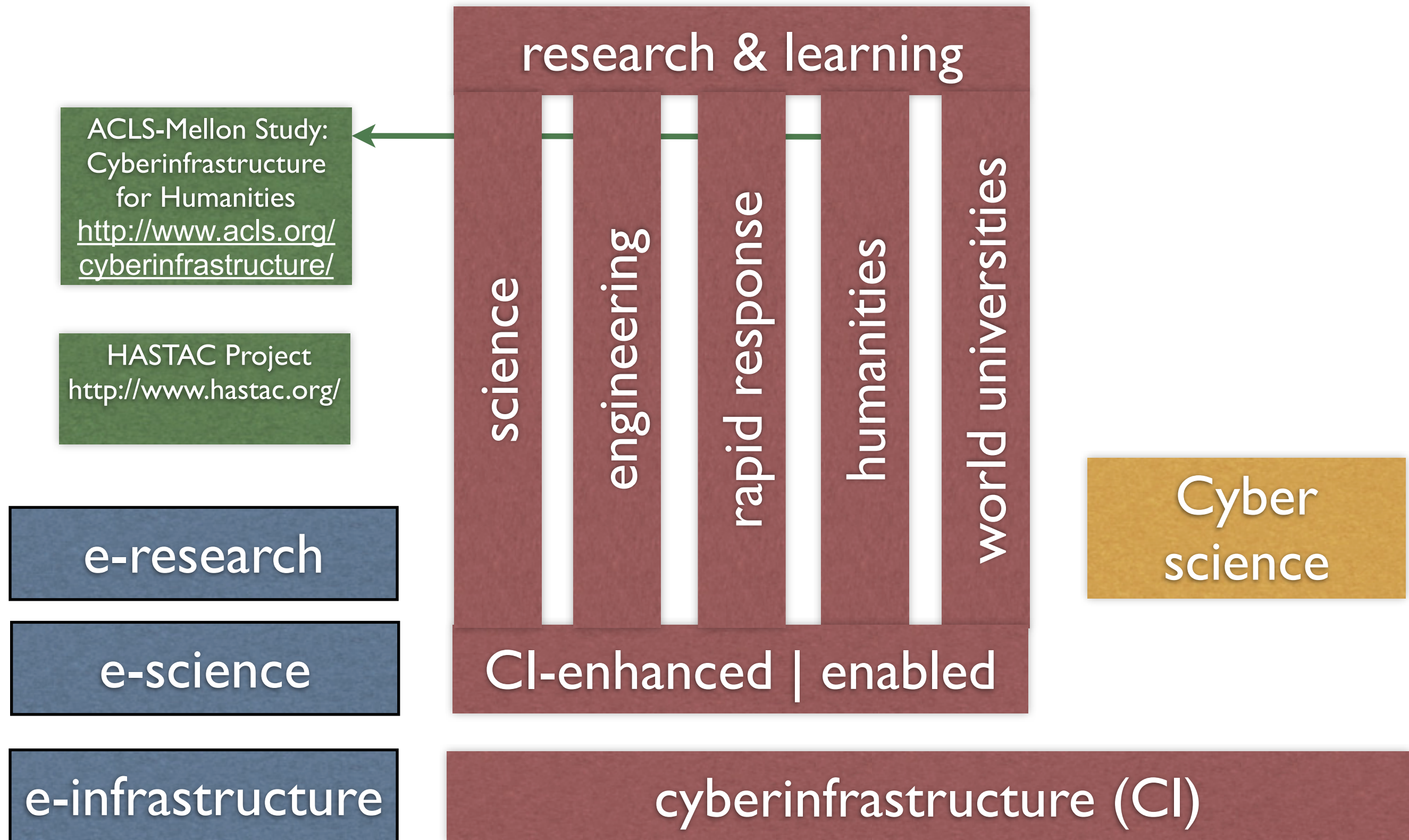
e-infrastructure

cyberinfrastructure (CI)

e = electronic | enhanced | enabled

D. E. Atkins

Dualities

| cyberinfrastructure | → enables → ← | research & development |

CI is both an object and means for R&D

| collaboration | → enables → ← | CI environments |

Multi-stakeholder collaboration required to create, provision, and apply CI; CI supports collaborations across time and distance (geographic, disciplinary, institutional)
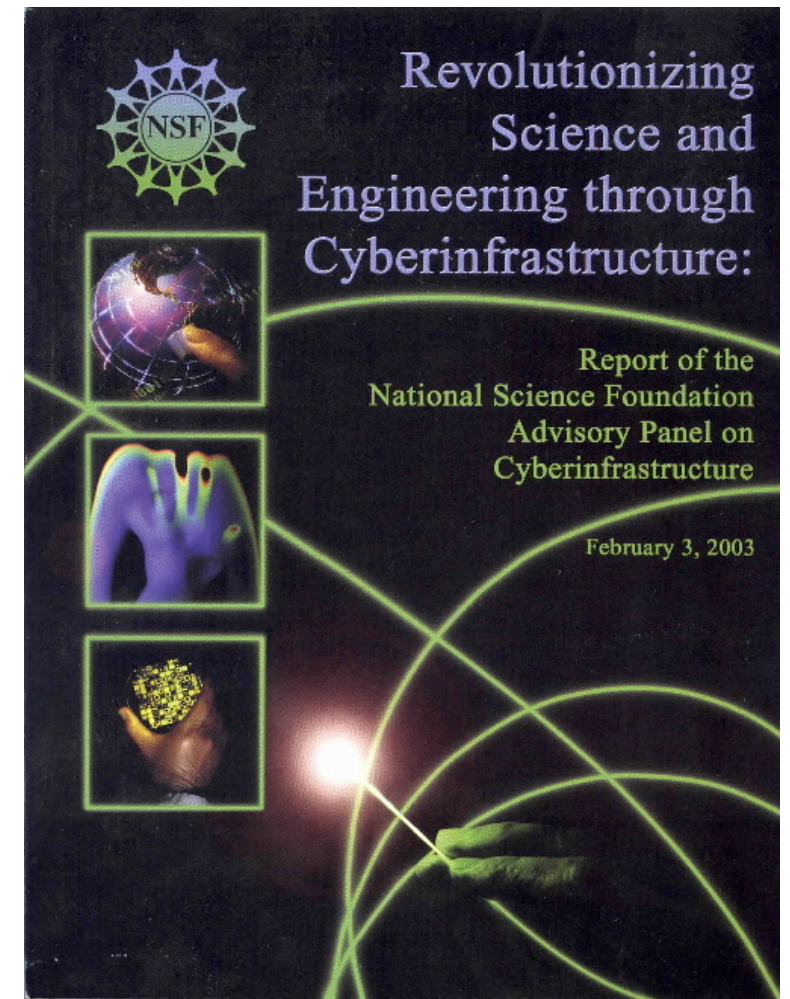
| learning | education | → enables → ← | CI environments |

Learning and workforce development initiatives required to create and use CI; CI enables/enhances learning/education

D. E. Atkins

NSF Blue Ribbon Advisory Panel on Cyberinfrastructure

"a new age has dawned in scientific and engineering research, pushed by continuing progress in computing, information, and communication technology, and pulled by the expanding complexity, scope, and scale of today's challenges. The capacity of this technology has crossed thresholds that now make possible a comprehensive "cyberinfrastructure" on which to build new types of scientific and engineering knowledge environments and organizations and to pursue research in new ways and with increased efficacy."

Revolutionizing Science and Engineering through Cyberinfrastructure:

Report of the National Science Foundation Advisory Panel on Cyberinfrastructure

February 3, 2003

Daniel E. Atkins, Chair
University of Michigan
Kelvin K. Droegemeier
University of Oklahoma
Stuart I. Feldman
IBM
Hector Garcia-Molina
Stanford University
Michael L. Klein
University of Pennsylvania
David G. Messerschmitt
University of California at Berkeley
Paul Messina
California Institute of Technology
Jeremiah P. Ostriker
Princeton University
Margaret H. Wright
New York University

http://www.nsf.gov/od/oci/reports/toc.jsp

Vision and Activities Based on Broad and Diverse Community Engagement

Advances in components of CI-systems for S&E R&E

Complex, multi-scale, multidisciplinary S&E research challenges

Revolutionizing Science and Engineering through Cyberinfrastructure:

Report of the National Science Foundation Advisory Panel on Cyberinfrastructure

February 3, 2003

30+ disciplinary workshops on CI vision & impact

NSF internal working groups

NSF'S CYBERINFRASTRUCTURE VISION FOR 21ST CENTURY DISCOVERY

NSF Cyberinfrastructure Council

NATIONAL · SCIENCE · FOUNDATION

CI Council, Directorate/Office CI Activities, OCI, ACCI

NSB & Community Input

Vision Framework

| High Performance Computing | Data, Data Analysis & Visualization | Virtual Organizations | Learning & Workforce Development |

- *All directorates and offices support cyberinfrastructure.*
- *Science-driven partnerships between creation, provisioning and use of CI*
- *Supports integrated research and education and broadened access and participation.*

Cyberinfrastructure

www.nsf.gov/oci/

Still looking for a few more Program Officers to join the OCI Adventure Team.

New NSF Strategic Plan

Includes many imperatives for innovation in provisioning and transformative application of cyberinfrastructure to discovery and learning.

Available at
http://www.nsf.gov/pubs/2006/nsf0648/nsf0648.jsp

Some Science Drivers

- Inherent **complexity and multi-scale** nature of todays frontier science challenges.

- Requirement for **multi**-disciplinary, **multi**-investigator, **multi**-institutional approach (often international).

- High **data intensity** from simulations, digital instruments, sensor nets, observatories.

- Increased value of data and demand for data **curation & preservation** of access.

- Exploiting infrastructure **sharing** to achieve better stewardship of research funding.

- Strategic need for **engaging more students** in high quality, authentic science and engineering education.

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NSF CI FY07 Budget Request
Total of $600M in CI Funding
with $182M in OCI

Cyberinfrastructure Funding

(Dollars in Millions)

	FY 2005 Actuals	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Percent
Biological Sciences	$77.00	$84.00	$90.50	$6.50	7.7%
Computer and Information Science and Engineering	45.32	63.00	68.00	5.00	7.9%
Engineering	52.00	52.00	54.00	2.00	3.8%
Geosciences	71.35	71.35	75.00	3.65	5.1%
Mathematical and Physical Sciences	56.52	59.30	63.56	4.26	7.2%
Social, Behavioral and Economic Sciences	20.39	20.54	20.54	-	-
Office of Cyberinfrastructure	123.28	127.12	182.42	55.30	43.5%
Office of International Science and Engineering	0.22	1.00	1.05	0.05	5.0%
Office of Polar Programs	25.38	26.24	26.24	-	-
Subtotal, Research and Related Activities	471.47	504.55	581.31	76.76	15.2%
Education and Human Resources	20.27	15.02	15.52	0.50	3.3%
Total, Cyberinfrastructure Funding	$491.74	$519.57	$596.83	$77.26	14.9%

Totals may not add due to rounding.

Achieving the NSF CI (e-science) Vision requires synergy between 3 types of activities

Transformative Application - to enhance discovery & learning

Provisioning - Creation, deployment and operation of advanced CI

Borromean Ring: The three rings taken together are inseparable, but remove any one ring and the other two fall apart. See www.liv.ac.uk/~spmr02/rings/

catalyzes

provides shared and connecting CI

Office of Cyberinfrastructure

R&D to enhance technical and *social* effectiveness of future CI environments

D. E. Atkins

High Performance Computing

increasingly important tool for understanding
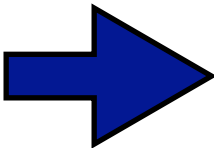
Life
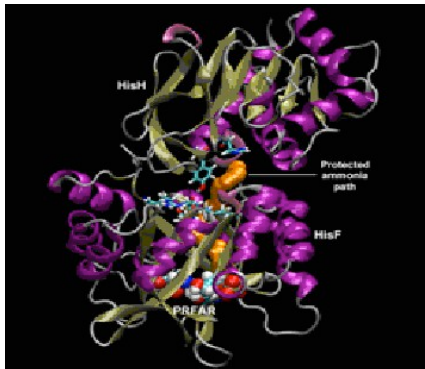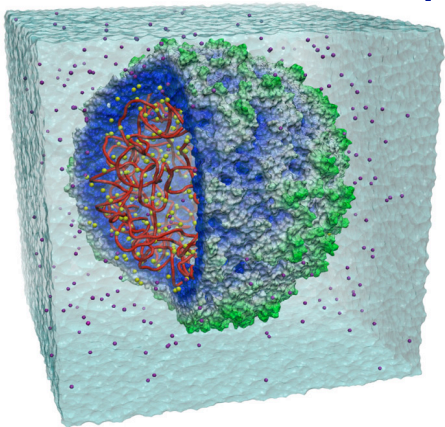
Satellite tobacco mosaic virus, P. Freddolino et al.

Aldehyde dehydrogenase, T. Wymore and S. Brown
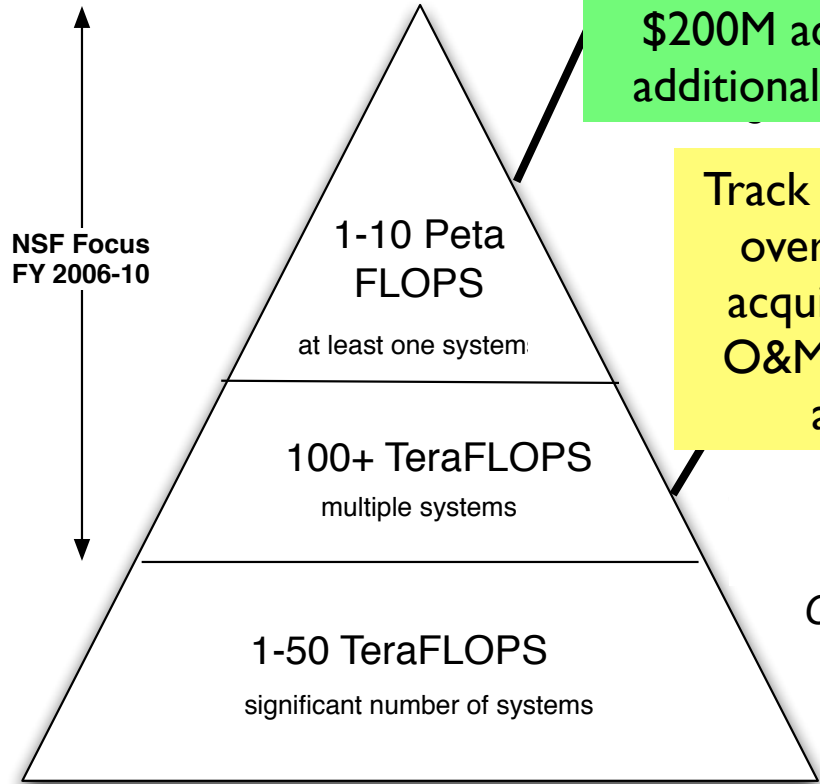
Track 1: One solicitation funded over 4 years: $200M acquisition + additional O&M cost.

Track 2: Four solicitations over 4 years: $30M/yr acquisition + additional O&M cost. First track 1 approved 8-07

NSF Focus FY 2006-10

1-10 Peta FLOPS
at least one system

100+ TeraFLOPS
multiple systems

1-50 TeraFLOPS
significant number of systems

Campus Level
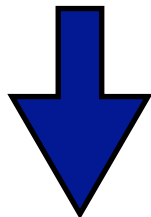
Matter
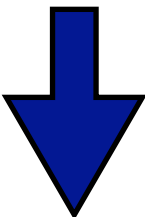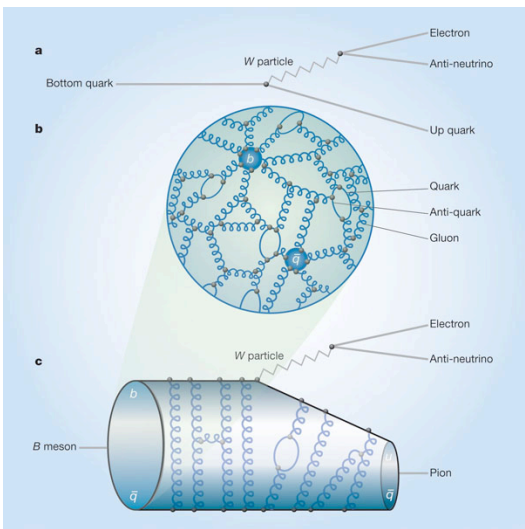
I. Shipsey

The Environment

Society

John Q Public
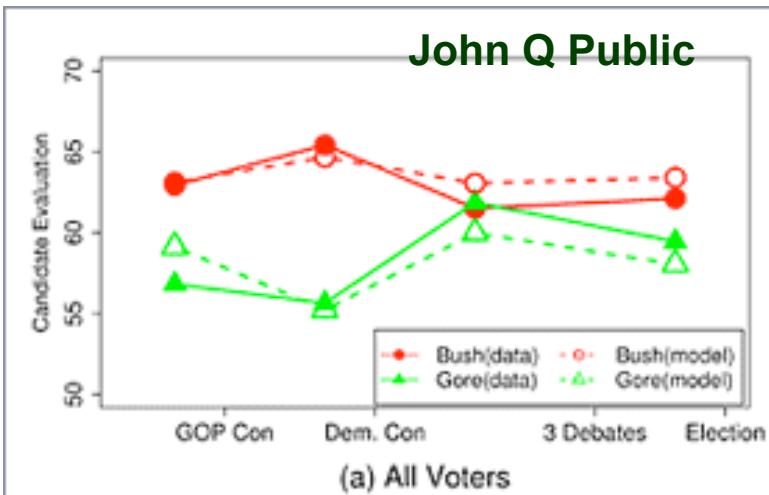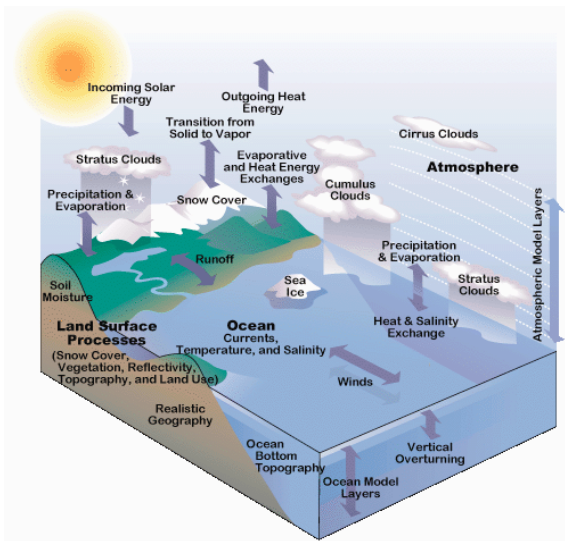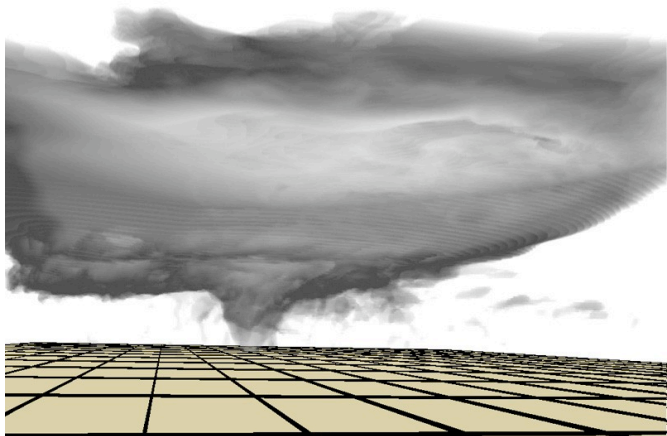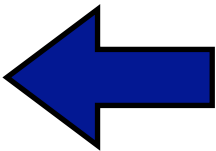
S.-Y. Kim, M. Lodge, C. Taber.
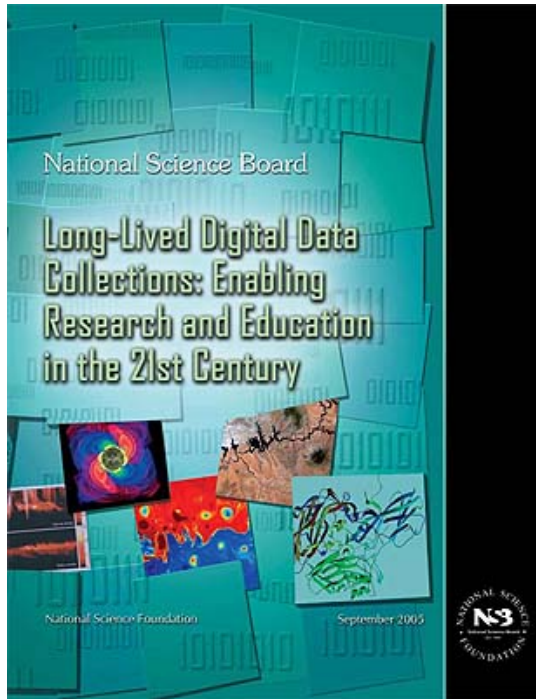
- Challenges: **increased scale, heterogeneity, and re-use value** of digital scientific information and data. Inadequate digital preservation strategy of long-lived data.

- Taking initial steps to **catalyze the development** of a federated, global system of science and engineering data collections that is open, extensible, evolvable, (and appropriately curated and long-lived.)

- Complemented by a **new generation of tools** and services to facilitate data mining, integration, analysis, visualization essential to transforming data into knowledge.

- NSF Leadership for OSTP/Interagency Working Group on Digital Data

National Science Board
Long-Lived Digital Data Collections: Enabling Research and Education in the 21st Century
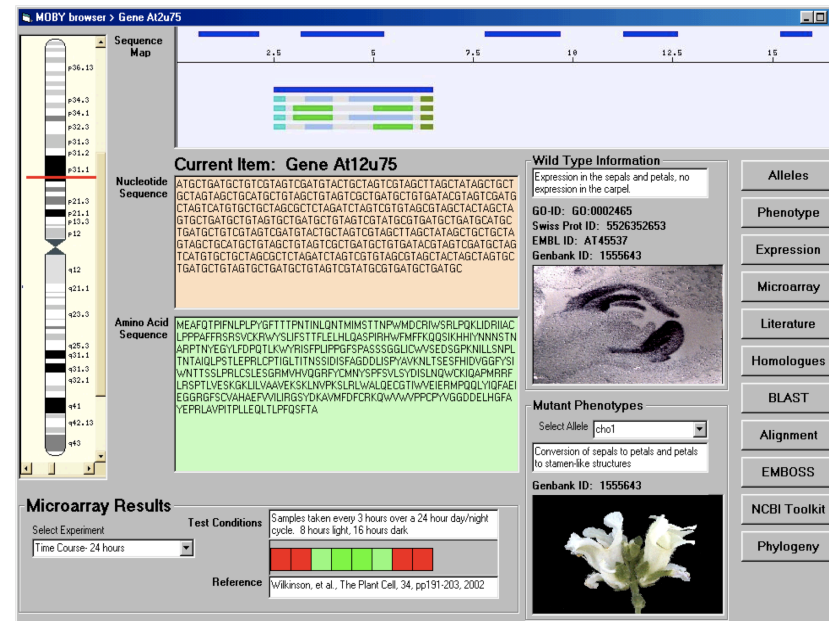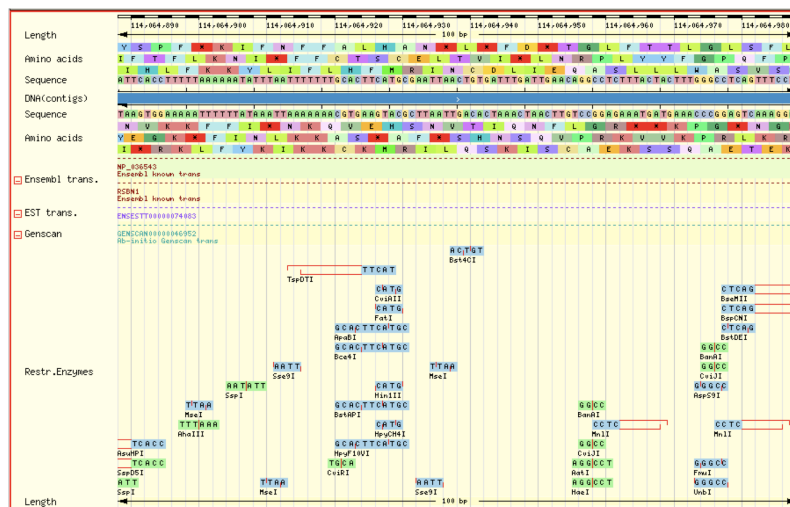
New Report: *To Stand the Test of Time*

To Stand the Test of Time

Long-term Stewardship of Digital Data Sets in Science and Engineering

A Report to the National Science Foundation from the ARL Workshop on New Collaborative Relationships: The Role of Academic Libraries in the Digital Data Universe

September 26–27, 2006
Arlington, VA

"Nature, to be commanded, must be obeyed."

Attributed to Francis Bacon (1561–1626)
Novum Organum, bk.1, aph. 129 (1620)

Available online at http://www.arl.org/info/events/digdatarpt.pdf

Lead NSF Program Officer for Data Initiatives, Chris Greer is at this meeting.

Virtual Organizations
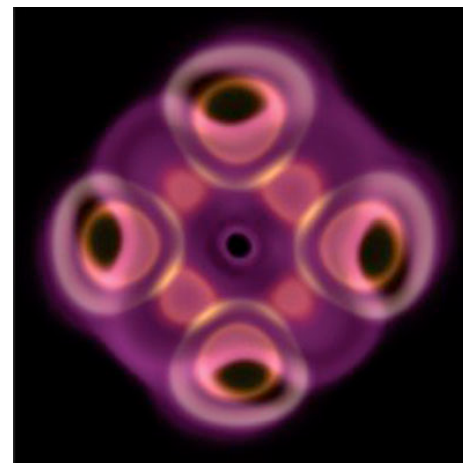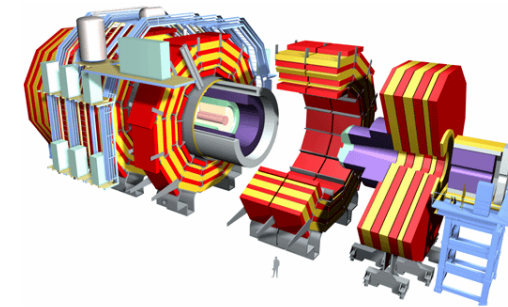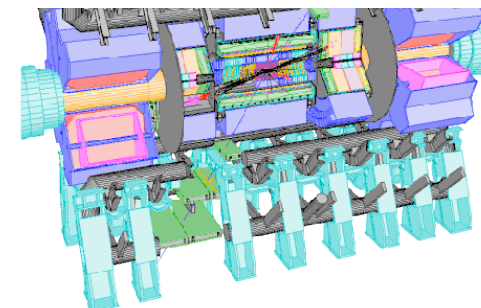
- To catalyze the development, implementation and evolution of a national cyberinfrastructure that integrates both physical and cyberinfrastructure assets and services.

- To promote and support the establishment of world-class VOs that are secure, efficient, reliable, accessible, usable, pervasive, persistent and interoperable, and that are able to exploit the full range of research and education tools available at any given time

- To support the development of common cyberinfrastructure resources, services, and tools that enable the effective, efficient creation and operation of end-to-end cyberinfrastructure systems for and across all science and engineering fields, nationally and internationally.

NVO

LEAD

iVDgL

CMS

ATLAS

NEES

NanoHub

Instances of Virtual Organizations (VOs)

People*   People*   People*

Interfaces for interaction, workflow, visualization and collaboration for distributed teams in domain/project specific and potentially functionally-complete VOs.

Mechanisms for flexible secure, coordinated resource/services sharing among dynamic collections of individuals, institutions, and resources (the Grid or service layer problem)

Distributed, heterogeneous services for:

Computation

Data, information management

Sensing, observation, activation in the world

Alternate Names for Instances of VOs:
• Co-laboratory
• Collaboratory
• Grid (community)
• Network
• Portal
• Gateway
• Hub
• Virtual Research Environment (VRE)
• Cyberinfrastructure Collaborative
• Other?

Office of Cyberinfrastructure   * People engaged in discovery and learning as individuals and in teams.   D. E. Atkins

Some Attributes of Grid-enabled VOs

- Technical performance level of resource components: computer, data pipes, storage capacity.

- Extent, diversity and functional completeness of shared resources.

- Extent of reuse of components from elsewhere.

- Extent of interoperability with other VOs

- The model for sustainability and evolution

- Extent of support for multiple outcomes: research, educational (multiple levels), societal engagement, rapid response

HPC

Balanced investment

"Griding"

D. E. Atkins

The Grid Movement

VO-substrate: International R&E Networking
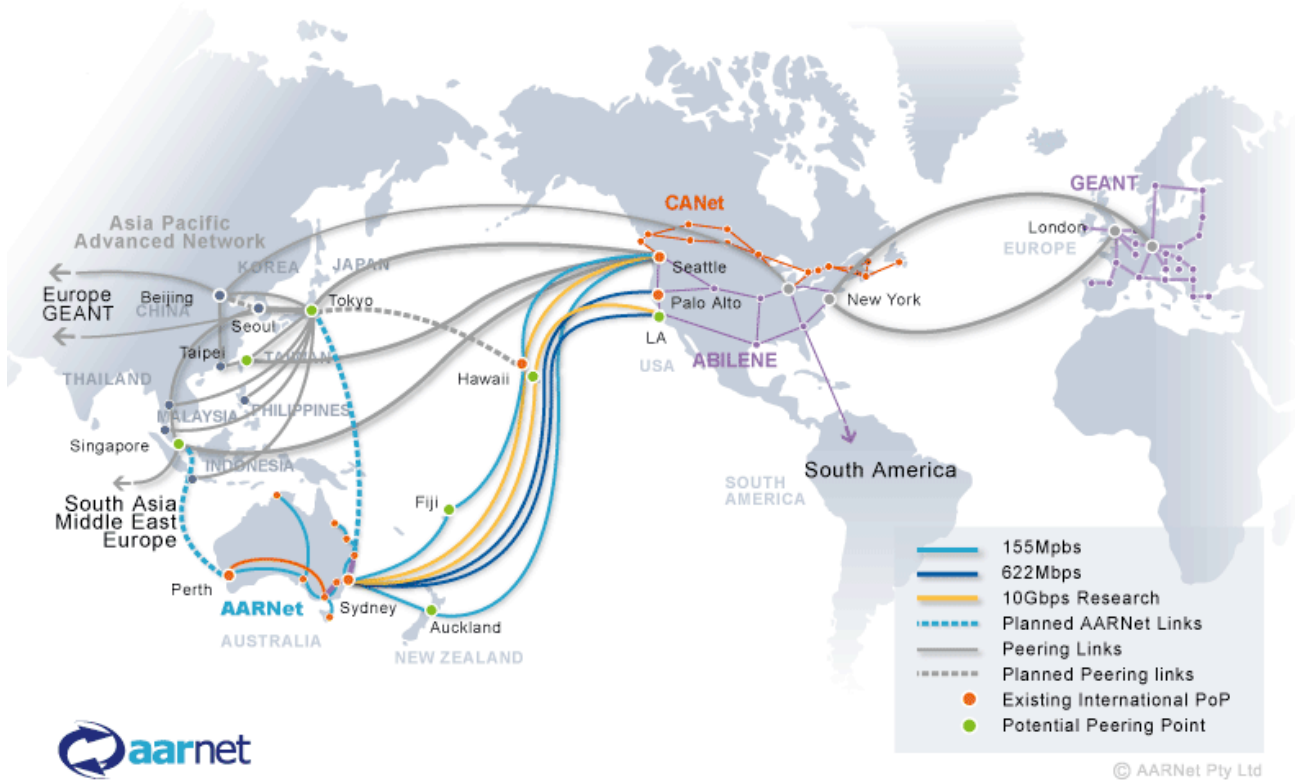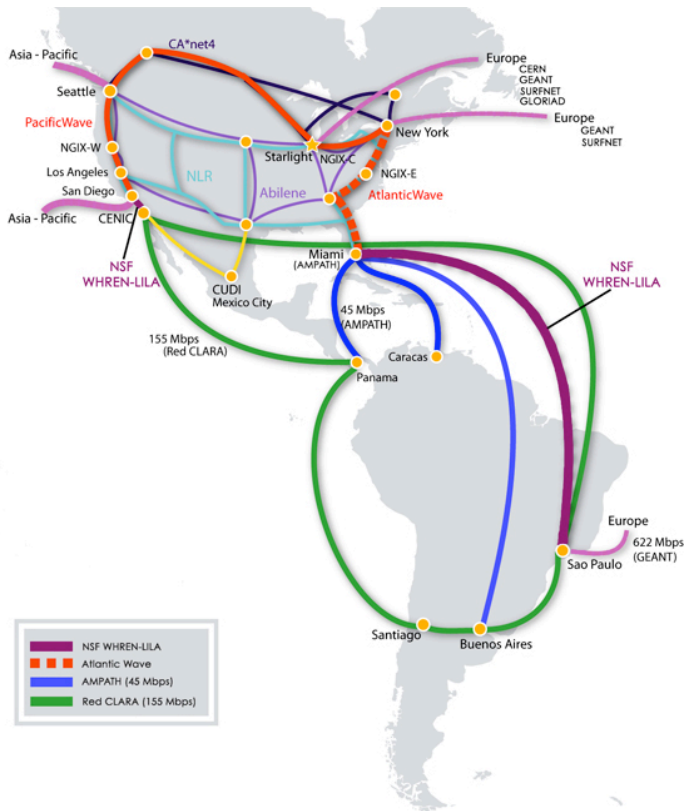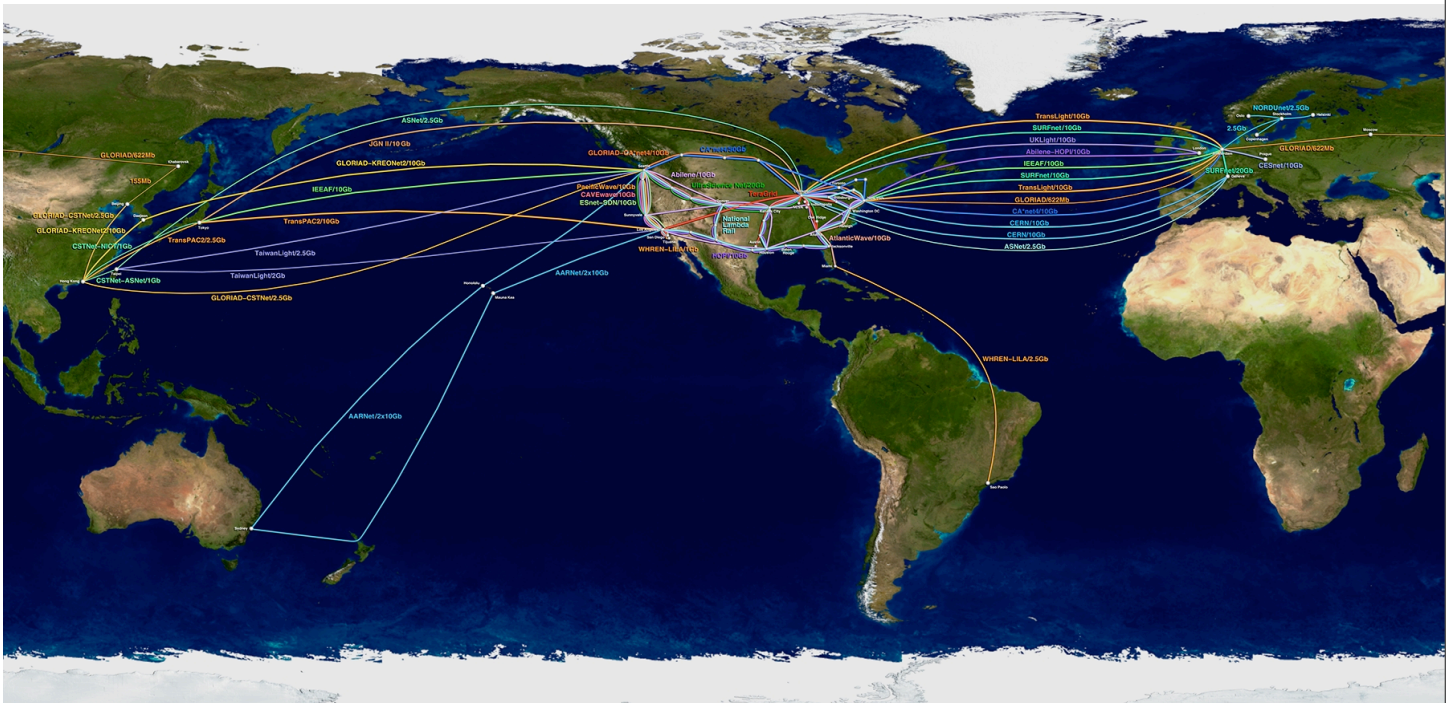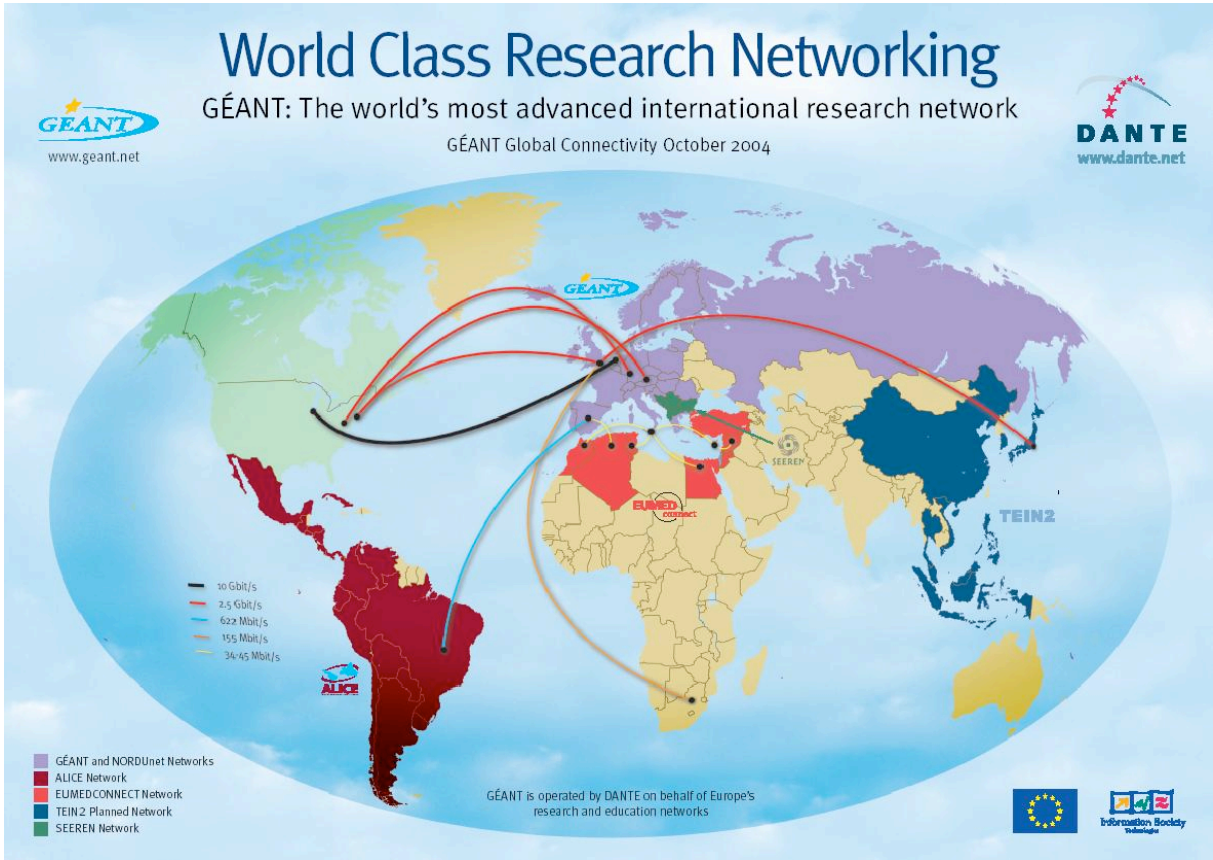
Globus.org Page View, Nov. 2006
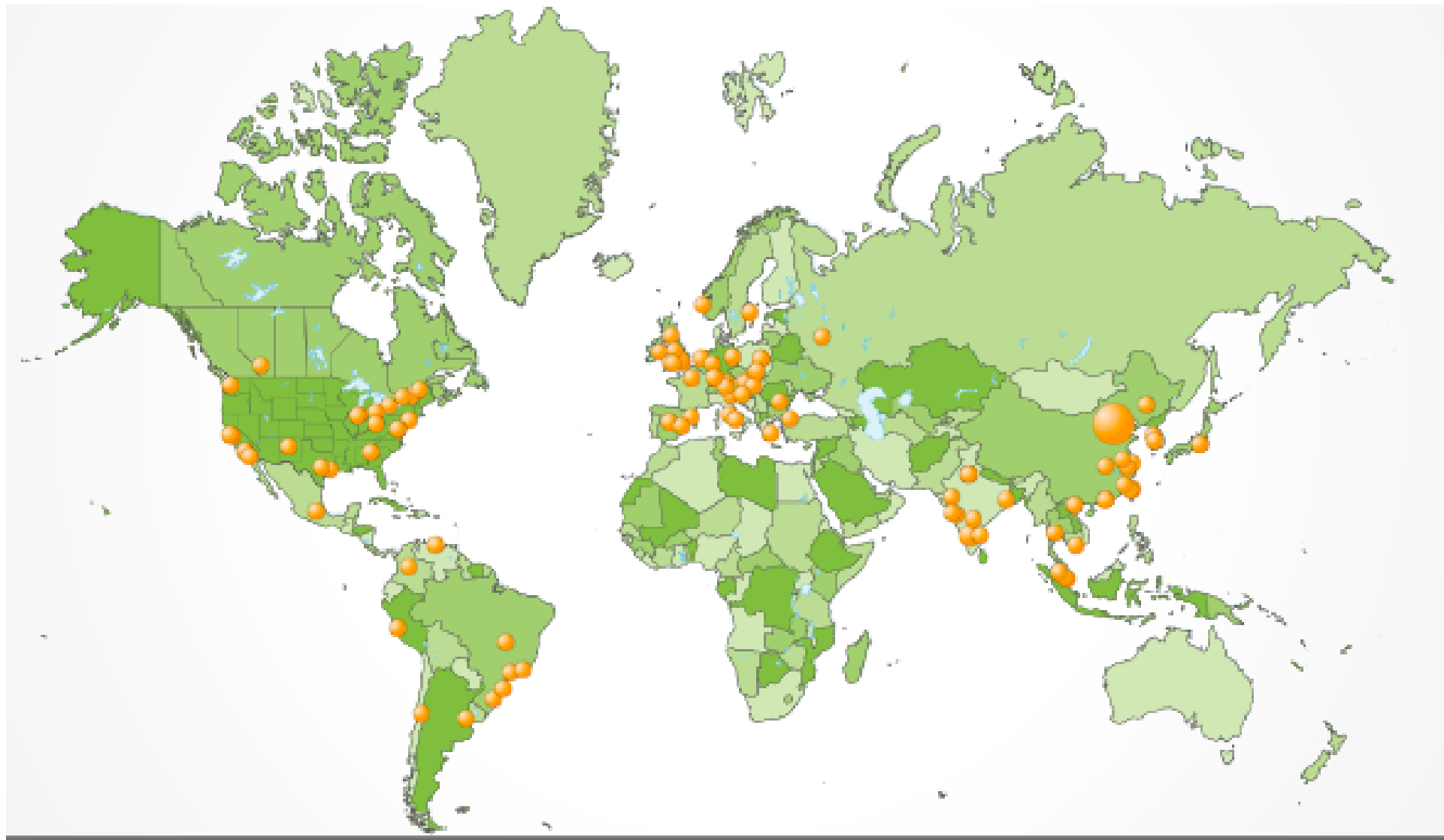
globus.org pageviews during November 2006
196,000 in total, each dot is a location with > ~100

Globus.org Downloads, Nov. 2006

globus.org downloads of software during November 2006 196,000 in total, each dot is a location with > ~100
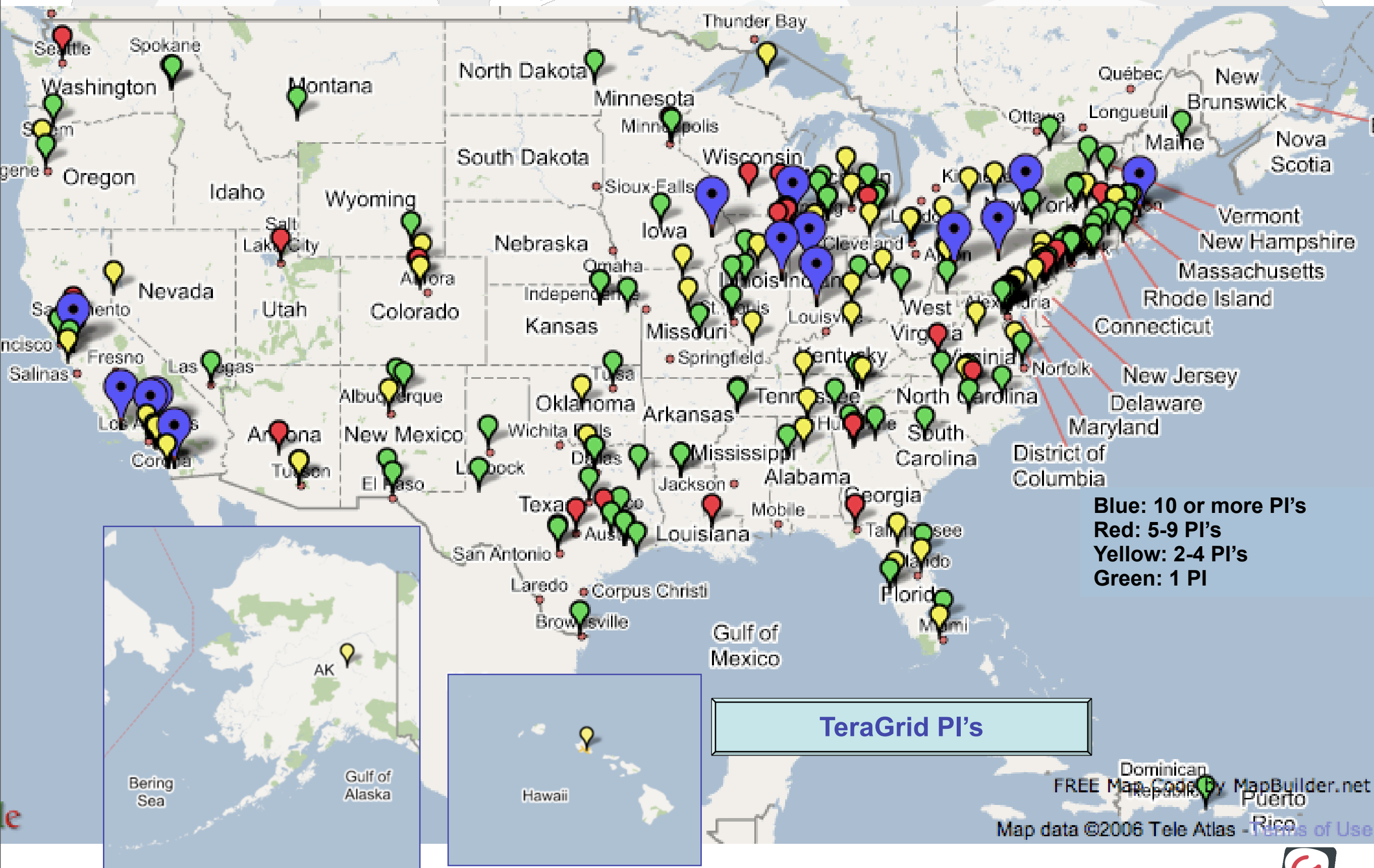
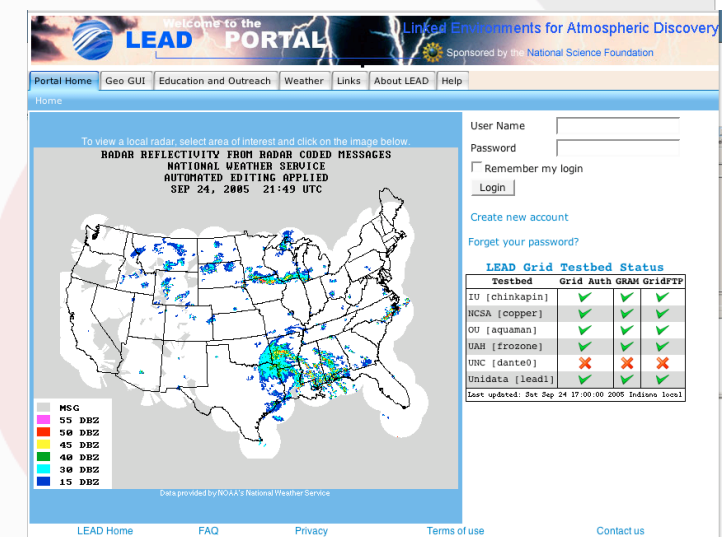*D. E. Atkins*

TeraGrid: Integrating NSF Cyberinfrastructure
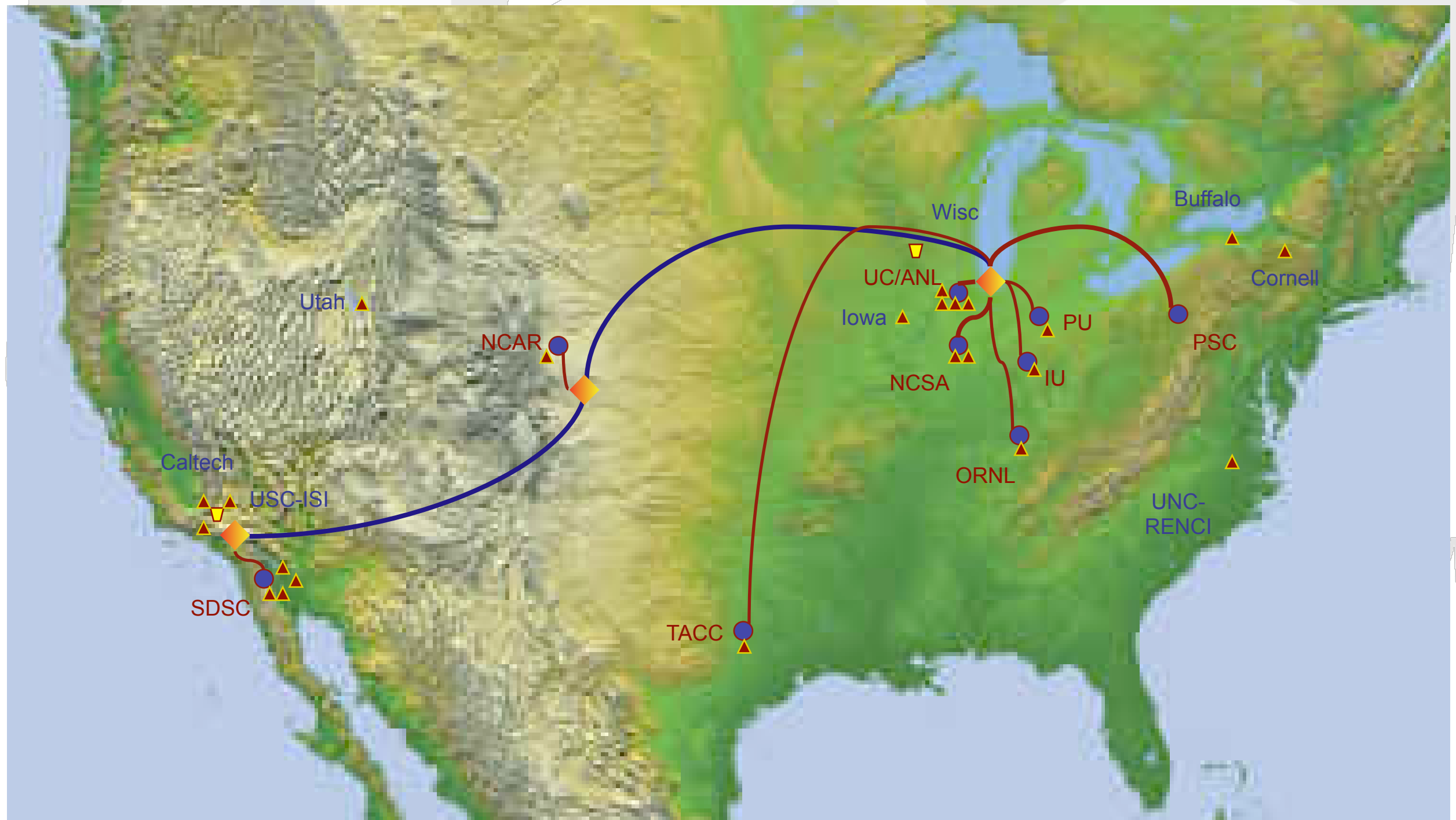
TeraGrid is a facility that integrates computational, information, and analysis resources at the San Diego Supercomputer Center, the Texas Advanced Computing Center, the University of Chicago / Argonne National Laboratory, the National Center for Supercomputing Applications, Purdue University, Indiana University, Oak Ridge National Laboratory, the Pittsburgh Supercomputing Center, and the National Center for Atmospheric Research.

Charlie Catlett (cec@uchicago.edu)

June 2006

TeraGrid PI's By Institution as of May 2006

Blue: 10 or more PI's
Red: 5-9 PI's
Yellow: 2-4 PI's
Green: 1 PI

TeraGrid PI's

FREE Map Code by MapBuilder.net

Map data ©2006 Tele Atlas - Terms of Use

Charlie Catlett (cec@uchicago.edu)

June 2006

TeraGrid™

22

TeraGrid Science Gateways Initiative: Community Interface to Grids
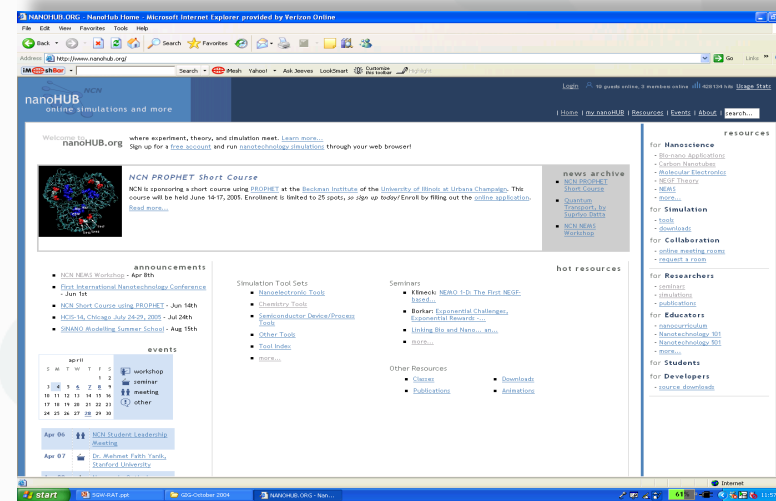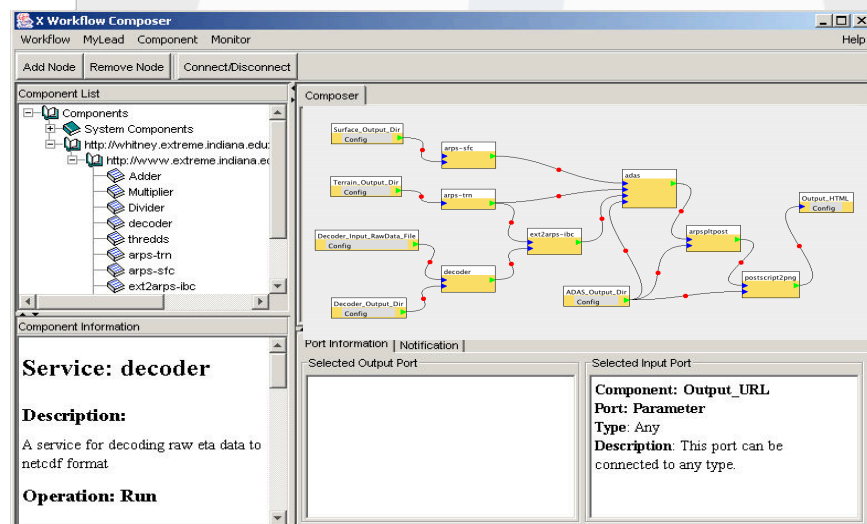
- **Common Web Portal or application interfaces (database access, computation, workflow, etc).**
- **"Back-End" use of TeraGrid computation, information management, visualization, or other services.**
- **Standard approaches so that science gateways may readily access resources in any cooperating Grid without technical modification.**

Charlie Catlett (cec@uchicago.edu)

June 2006

TeraGrid Science Gateway Partner Sites

21 Science Gateway Partners (and growing) - Over 100 partner Institutions

Charlie Catlett (cec@uchicago.edu)

June 2006

CI/VO Enabled Science
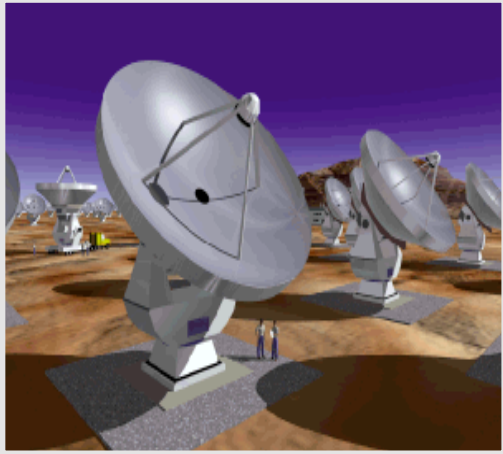
NVO and ALMA
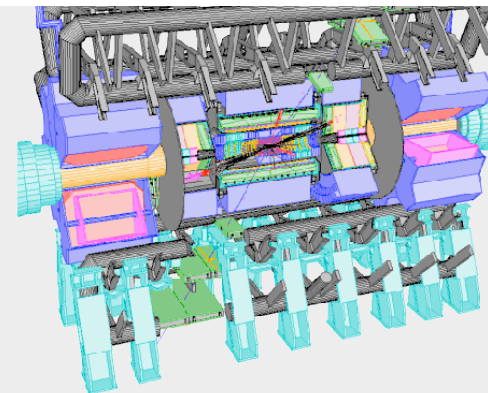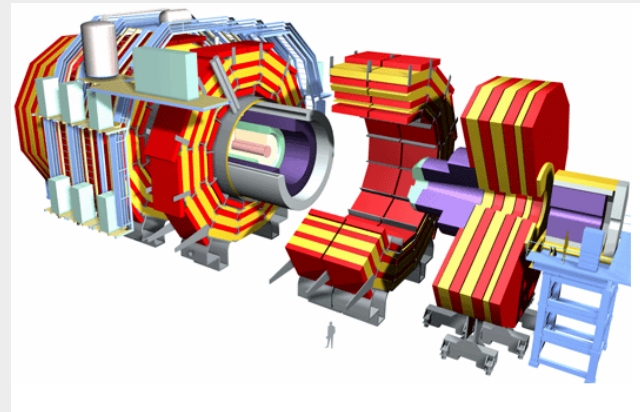
ATLAS and CMS
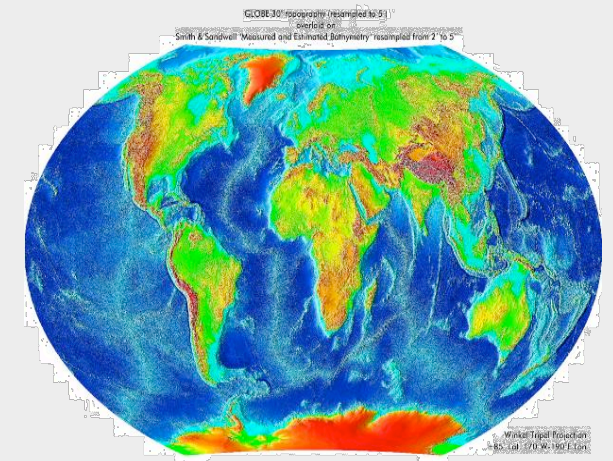
Climate Change

LIGO
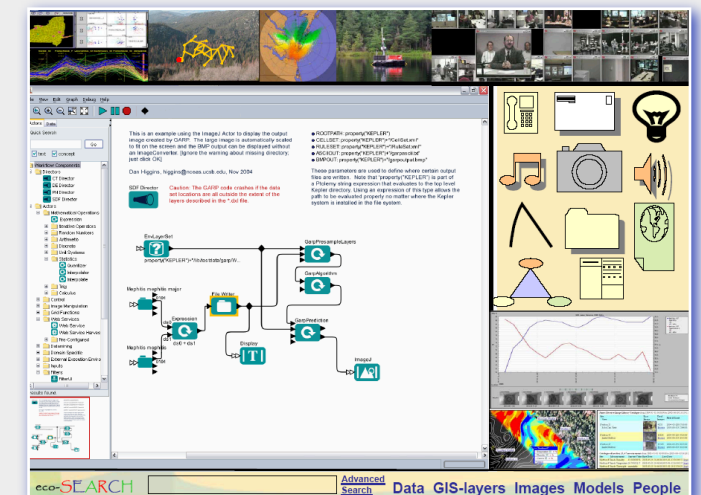
NEON

The number of international-scale projects is growing rapidly!

Virtual Organizations offer additional modes of interaction between People, Information, and Facilities

Time

	Same (synchronous)	Different (asynchronous)
Same	**ST-SP** **P**: Physical mtgs **I**: Print-on-paper books, journals **F**: Physical labs, studios, shops	**DT-SP** **P**: Shared notebook **I**: Library reserves **F**: Time-shared physical labs, ...
Different	**ST-DP** **P**: AV conference **I**: Web search **F**: Online instruments	**DT-DP** **P**: Email **I**: Knowbots **F**: Autonomous observatories

Geographic Place

Physical +
Virtual,
Not Physical
vs. Virtual

P: people, **I**: information, **F**: facilities, instruments

Let's look at a few real example Grid Science Gateways

(about a dozen … many more exist!)

These example slides courtesy of D. Gannon

27

NEESGrid

Realtime access to earthquake
Shake table experiments at remote sites.
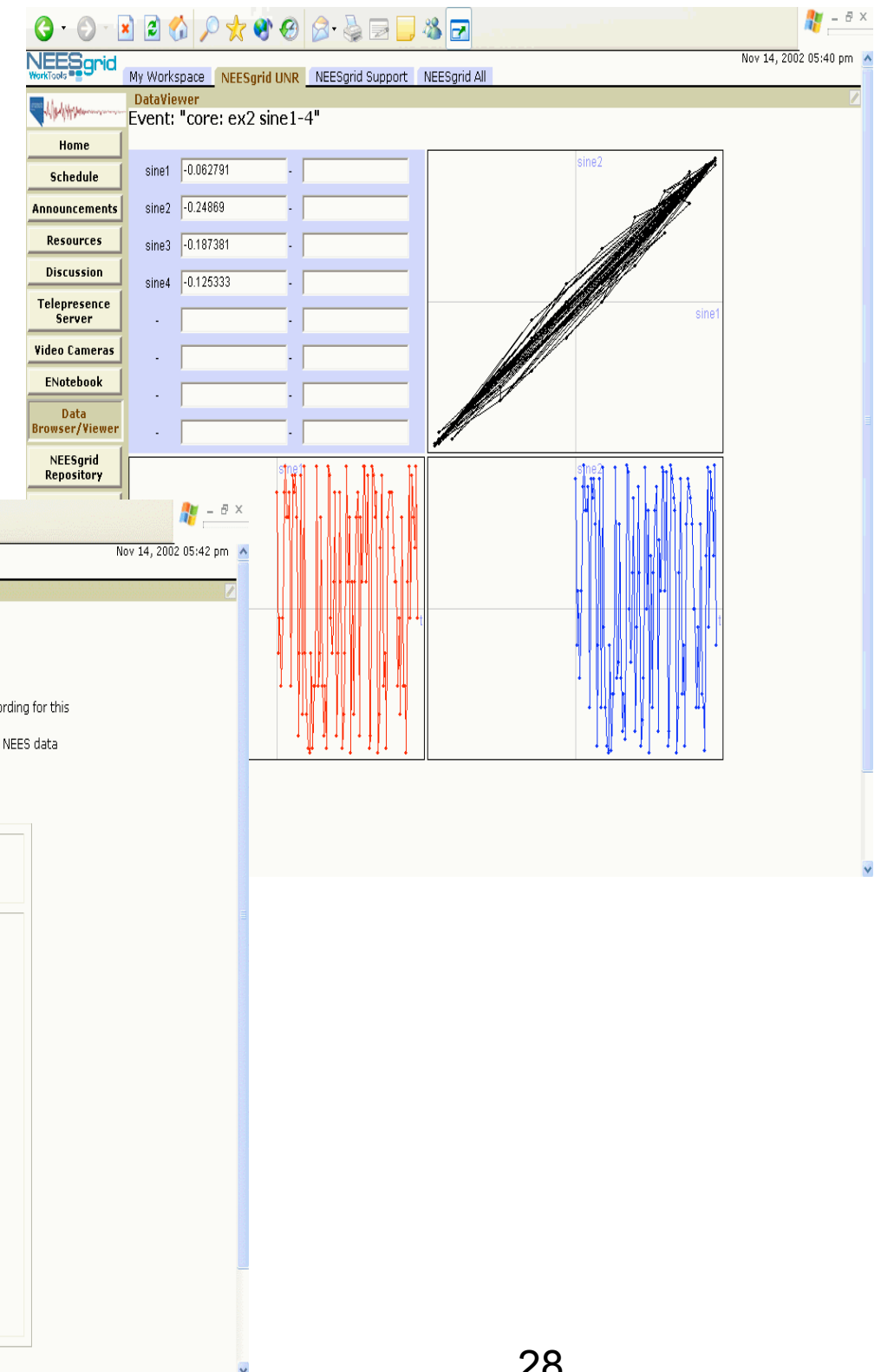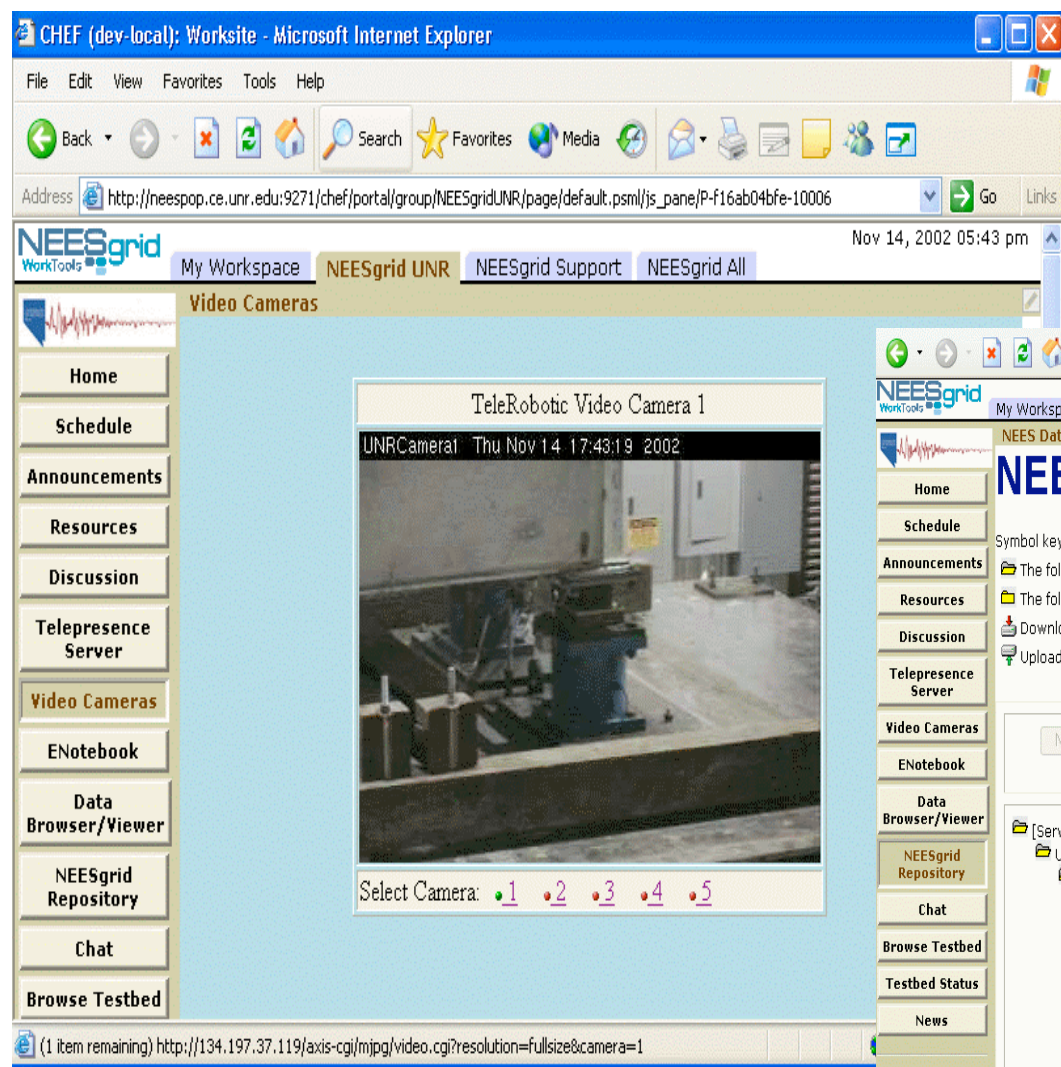
BIRN – Biomedical Information

Mesoscale Meteorology

NSF LEAD project - making the tools that are needed to make accurate predictions of tornados and hurricanes.
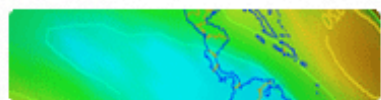 - Data exploration and Grid workflow

The LEAD Vision: Adaptive Cyberinfrastructure

DYNAMIC OBSERVATIONS

Analysis/Assimilation

Quality Control
Retrieval of Unobserved
Quantities
Creation of Gridded Fields

Prediction/Detection

PCs to Teraflop Systems

**Product Generation,
Display,
Dissemination**

Models and Algorithms Driving Sensors

The CS challenge: Build cyberinfrastructure services that provide adaptability, scalability, availability, useability, and real-time response.

End Users

NWS
Private Companies
Students

From D. Gannon
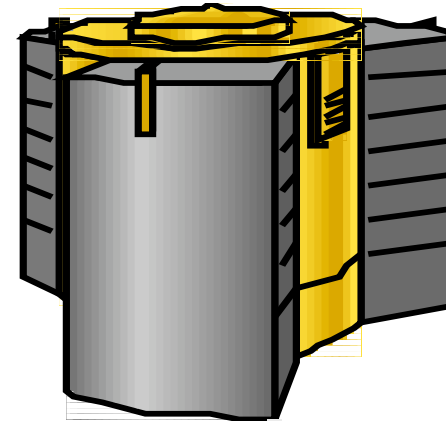
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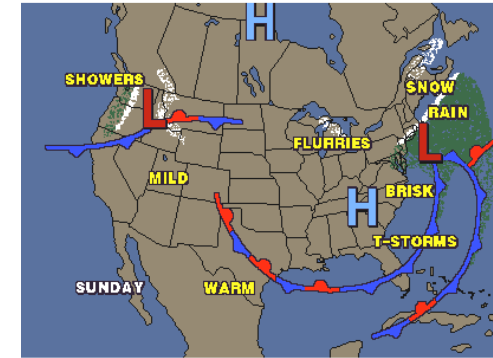
DYNAMIC OBSERVATIONS

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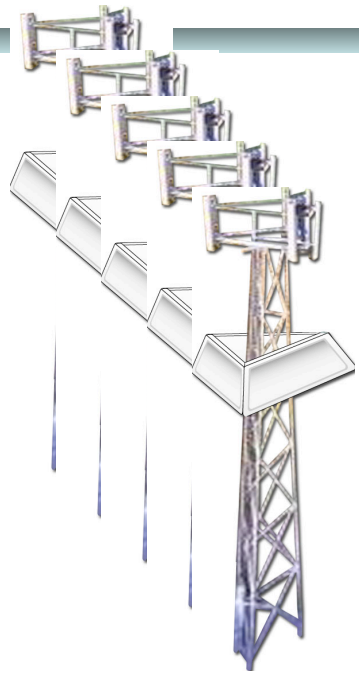
**Product Generation,
Display,
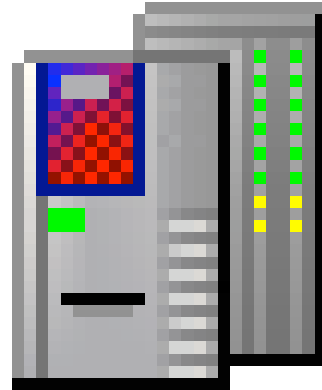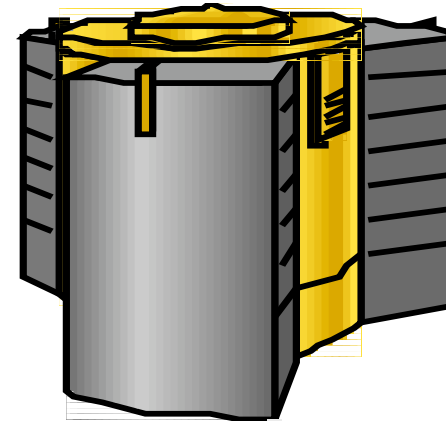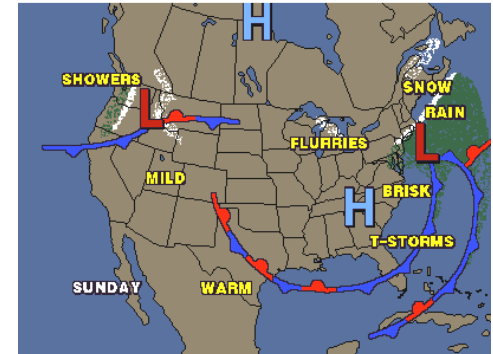Dissemination**
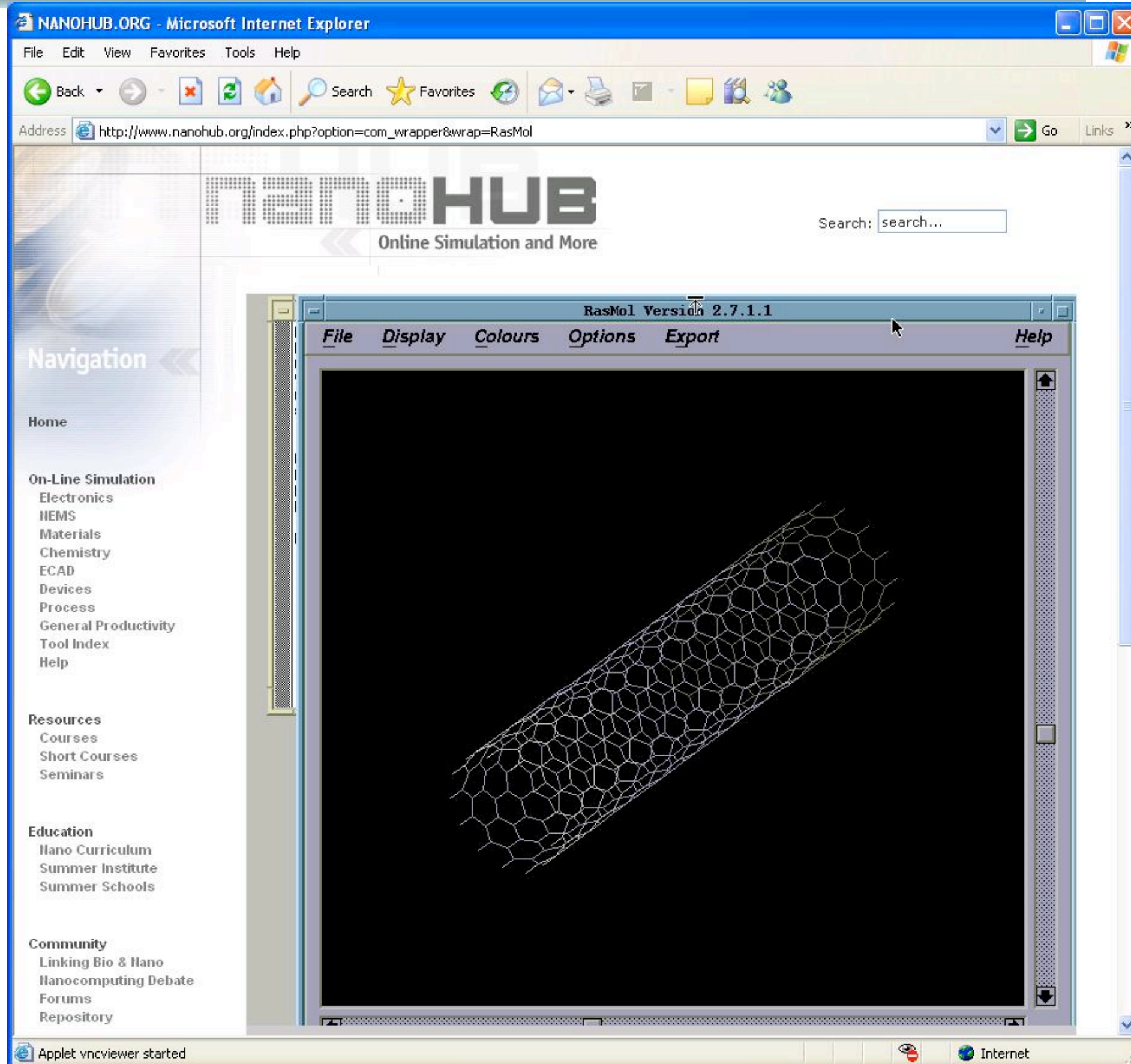
Models and Algorithms Driving Sensors

The CS challenge: Build cyberinfrastructure services that provide adaptability, scalability, availability, useability, and real-time response.

End Users

NWS
Private Companies
Students

From D. Gannon

Nanohub - nanotechnology
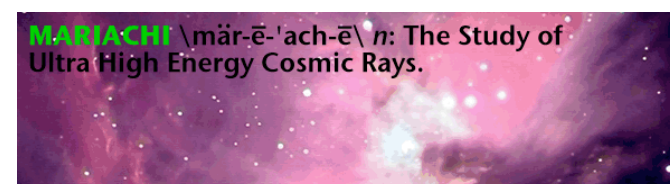
Learning & Workforce Development

- Learning **supported by** CI. (cyber-enabled learning).

- Workforce development **to create and use** CI for S&E research and education.

- **Broadened participation**: Exploit the new opportunities that cyberinfrastructure brings for … people who, because of physical capabilities, location, or history, have been excluded from the frontiers of scientific and engineering research and education.

- Explore CI support for **integrated research and education**.
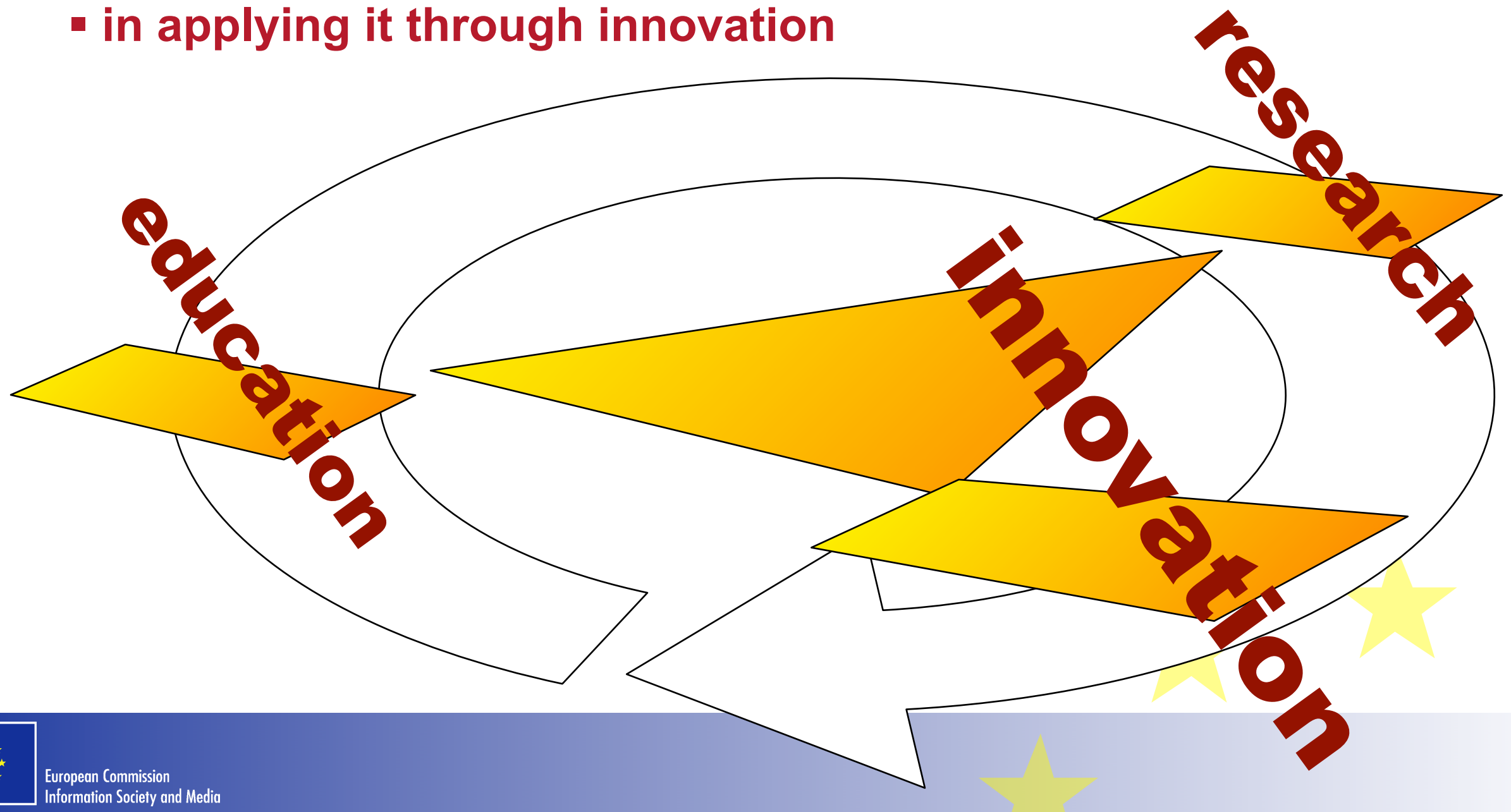

BIOINFORMATICS CI INSTITUTE

Engaging People in Cyberinfrastructure
EPIC

MARIACHI \mär-ē-ˈach-ē\ n: The Study of Ultra High Energy Cosmic Rays.
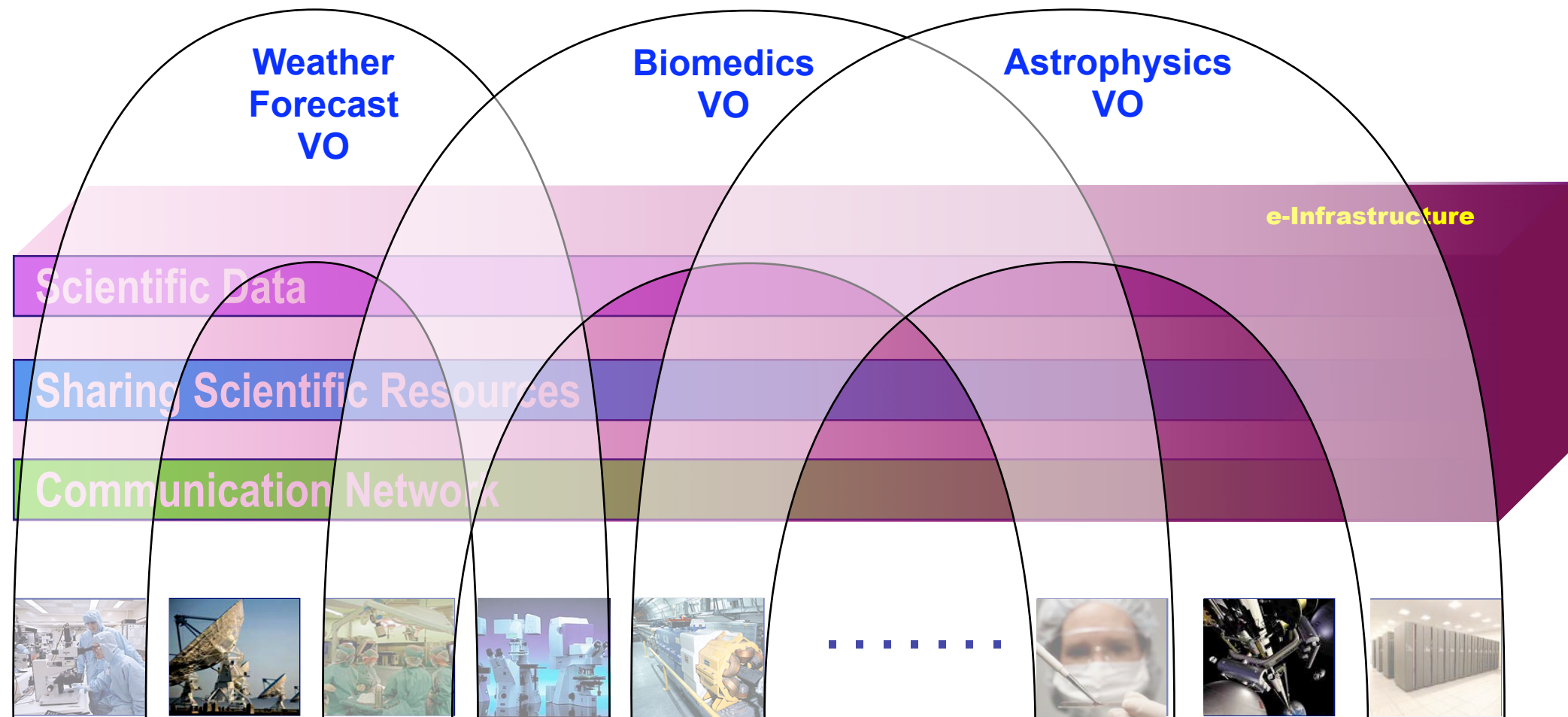MARIACHI

cyberbridges
CyberBridges

To be a genuinely competitive knowledge economy, Europe must be better

- in producing knowledge through research
- in diffusing it through education
- in applying it through innovation

Bringing the best brains together

Sharing the best scientific resources

Weather Forecast VO

Biomedics VO

Astrophysics VO

e-Infrastructure

Scientific Data

Sharing Scientific Resources

Communication Network

. . . .

Producing the best science

European Commission
Information Society and Media
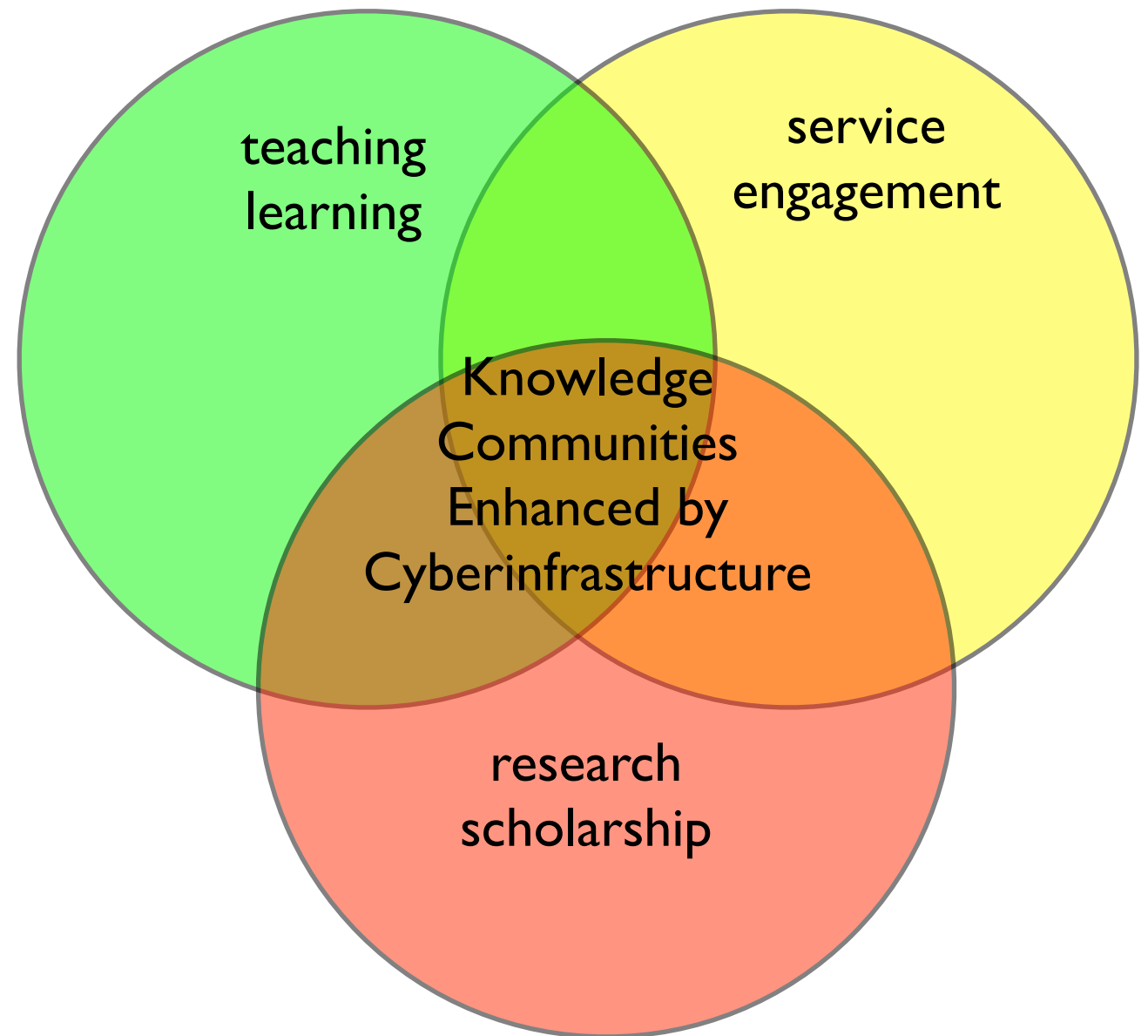
And while we are at it...

- can we create CI platforms in support of research, learning, and societal engagement in ways that exploit complementarity between them?
  - *"Better than being there."*
  - *Pasteur's Quadrant research*
  - *Ubiquitous learning ecologies*

teaching learning

service engagement

Knowledge Communities Enhanced by Cyberinfrastructure

research scholarship

The opportunity is more than networked information. It is about using ICT/CI as an enhancement platform for knowledge-based communities to learn, discover, and engage in more "barrier free" ways.

D. E. Atkins
atkins@umich.edu

New Learning and Discovery Ecosystems:

The Meta University
A Personal View

What we are observing is the early emergence of a *Meta University* -- a transcendent, accessible, empowering, dynamic, communally-constructed framework of open materials and platforms on which much of higher education worldwide can be constructed or enhanced.

From Charles M. Vest, President Emeritus of MIT

The Meta University

- Will enable -- not replace -- residential campuses
- Will bring cost efficiencies to institutions through shared development;
- Will be adaptable -- not prescriptive;
- Will serve both teachers and learners;
- Will speed the propagation of high-quality education and scholarship;
- Will build capacity for economic development;
- Will build bridges across cultures and political boundaries; and
- Will be particularly important to the developing world.

From Charles M. Vest, President Emeritus of MIT

39

Something to ponder.....

Global Needs

Half of the world's population is under 20 years old.

Today, there are over 30 million people who are fully qualified to enter a university, but there is no place available. This number will grow to over 100 million during the next decade.

To meet the staggering global demand for advanced education, a major university would need to be created every week.

"In most of the world, higher education is mired in a crisis of access, cost, and flexibility. The dominant forms of higher education in developed nations–campus based, high cost, limited use of technology–seem ill-suited to addressing global education needs of the billions of young people who will require it in the decades ahead."

Sir John Daniels

From James J. Duderstadt, President Emeritus, U. of Michigan

Chinese and English on the Go (CHENGO)

http://www.elanguage.cn/
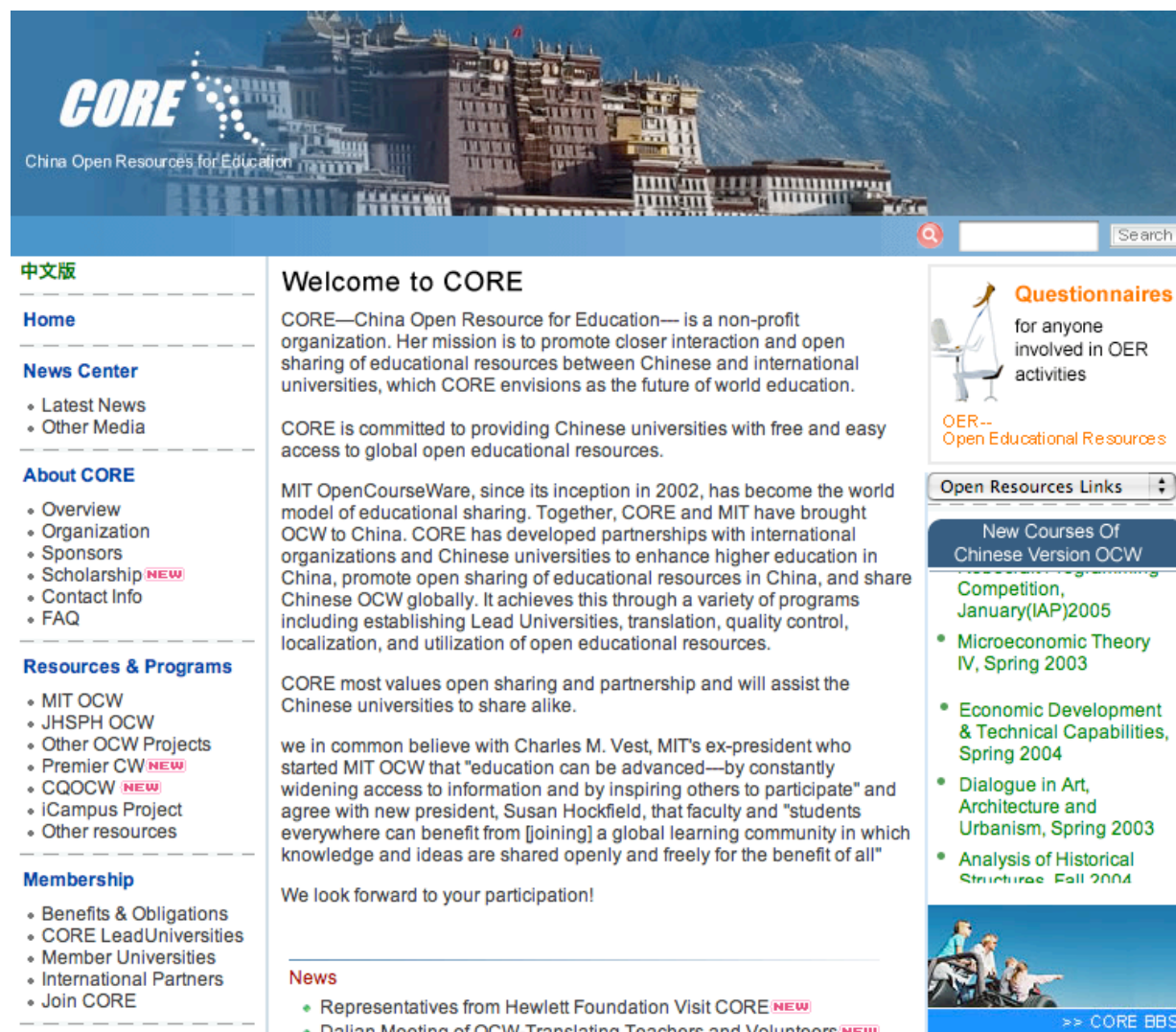
OCW & China Open Resources for Education (CORE)

New Opportunities

*"Cyberinfrastructure-enhanced knowledge communities offer the potential for enabling a new wave of global-scale collaboration across multiple disciplines, geography, and institutions. It could empower a revolution in **what** science explores, **how** it is done, and **who** participates.*

*Realizing this potential will, however, also required **a new wave of commitment to collaboration** between the complex array of stakeholders necessary to create, deploy, sustain, and apply cyberinfrastructure in transformative ways.*

Cyberinfrastructure both enables and requires a new wave of collaboration."

D. E. Atkins, Keynote for EDUCAUSE Australasia, Auckland, NZ, April 5-8, 2005

Office of Cyberinfrastructure

D. E. Atkins

- *and Networks are the fundamental platform need to remove barriers of time and distance. Thanks for all you are doing.* 謝謝

- 謝謝您做着的所有

- Questions and Discussion
  問題